

BERESKIN & PARR

UNITED STATES

Title: METHOD AND APPARATUS FOR
MONITORING A COMPUTING
DEVICE

Inventor: Peter Daniel GRAY

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Title: Method and Apparatus for Monitoring a Computing Device

FIELD OF THE INVENTION

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[0001] The present invention relates to a method and apparatus for monitoring a computing device, and in some aspects, is more particularly concerned with a method and apparatus for detecting specified conditions in a computing device.

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BACKGROUND OF THE INVENTION

[0002] Many organizations employ the use of a system of one or more computing devices (e.g. servers) to provide its members (e.g. employees) with the necessary resources to perform various computing tasks. In some instances, a user or administrator of the system may wish to monitor and perform maintenance on the system from a remote location.

[0003] Several systems, methods and apparatus for monitoring and controlling computing devices remotely have been disclosed in the prior art. For example, PCT International Application No. PCT/US95/00180 (International Publication Number WO 95/22137) for METHODS AND APPARATUS FOR REMOTE MONITORING AND CONTROL OF AUTOMATED VIDEO DATA SYSTEMS, U.S. Patent No. 5,732,212 for a SYSTEM AND METHOD FOR REMOTE MONITORING AND OPERATION OF PERSONAL COMPUTERS, and PCT International Application No. PCT/US99/21891 (International Publication Number WO 00/17766) for a SYSTEM AND METHOD FOR ACCESSING AND OPERATING PERSONAL COMPUTERS REMOTELY relate to the remote monitoring of computing devices.

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[0004] The present invention relates to a method and apparatus for monitoring a computing device.

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[0013] In another aspect, the present invention relates to a method and apparatus for monitoring a computing device, where it is determined whether an output data signal comprises a prespecified string of characters or whether an output data signal has not comprised a prespecified string of characters within a prespecified interval, and where an error indicator is generated if the output data signal comprises a prespecified string of characters or if the output data signal has not comprised a prespecified string of characters within a prespecified interval respectively.

[0014] In another aspect, the present invention relates to a method and apparatus for monitoring a computing device, where one or more test signals are generated that simulate a press of a prespecified key on a keyboard, where it is determined whether a signal has not been received from a computing device to illuminate a prespecified light on the keyboard in response to the test signals, and where an error indicator is generated if the signal has not been received from the computing device to illuminate the prespecified light on the keyboard in response to the test signals.

[0015] In another aspect, the present invention relates to a method and apparatus for monitoring a computing device, where one or more ping requests are generated, where it is determined whether an echo response has not been received in response to a prespecified percentage of the one or more ping requests from a controlled computing device within a prespecified period of time, and where an error indicator is generated if an echo response has not been received in response to a prespecified percentage of the one or more ping requests from a controlled computing device within a prespecified period of time.

[0016] In another aspect, the present invention relates to a method and apparatus for monitoring a computing device, where a request to retrieve a web page from a controlled computing device is generated, where it is determined whether the web page was not successfully retrieved from the

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controlled computing device in response to the request, and where an error indicator is generated if the web page was not successfully retrieved from the controlled computing device in response to the request.

- 5 **[0017]** In another aspect, the present invention relates to a method and apparatus for monitoring a computing device in which a user may define a plurality of error conditions to be monitored.

- 10 **[0018]** The present invention is directed to an apparatus and method for monitoring a computing device, and in particular, according to some aspects of the present invention, to detect whether one or more error conditions are present in the computing device. These error conditions typically arise when the computing device is not functioning properly or in some specific manner. These error conditions are detected by monitoring the
15 electrical outputs of the controlled computer.

- 20 **[0019]** Advantageously, the present invention facilitates the monitoring of the computing device for error conditions automatically, without the need for ongoing direct maintenance of the computing device or monitoring device by a user.

- 25 **[0020]** Furthermore, the simplicity of the present invention, relative to some prior art devices that relate generally to the remote monitoring of a computing device, may allow an apparatus configured in accordance with the present invention to be constructed more compactly and less expensively than those prior art devices.

BRIEF DESCRIPTION OF THE DRAWINGS

- 30 **[0021]** For a better understanding of the present invention, and to show more clearly how it may be carried into effect, reference will now be made, by

way of example, to the accompanying drawings used to describe preferred embodiments of the present invention, and in which:

5 [0022] Figure 1 is a schematic diagram of an embodiment of the present invention;

[0023] Figure 2 is a schematic diagram that illustrates components of a monitoring device according to an embodiment of the present invention;

10 [0024] Figures 3A and 3B are schematic diagrams that illustrate components of a monitoring device in variant embodiments of the present invention; and

15 [0025] Figure 4 is a flowchart illustrating the steps of a method of monitoring a computing device in accordance with an embodiment of the present invention.

[0026] Similar references are used in different figures to denote similar components.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] The present invention relates generally to an apparatus and method for monitoring a computing device.

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[0028] Referring to Figure 1, a schematic diagram of an embodiment of the present invention in which components of a system shown generally as 10 for monitoring a computing device is provided. Importantly, system 10 comprises a monitoring device 20 designed in accordance with the present invention.

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[0029] In a preferred embodiment of the invention, monitoring device 20 is a device that can be connected between a controlled computing device 30 and a network 40. Advantageously, monitoring device 20 is not a personal computer (PC), but is a piece of external hardware that operates independently of controlled computing device 30 and that remains functional even if controlled computing device 30 has crashed or failed in any way. Monitoring device 20 will, in some instances, be less complex and less expensive to manufacture than a PC designed to perform the same functions as monitoring device 20.

[0030] Typically, controlled computing device 30 is a server PC which has been selected for monitoring by a user. However, controlled computing device 30 may also be one of a variety of other different computing devices for performing a variety of different functions, such as a web server, a client PC, a legacy computer system that does not otherwise attach to a network (such as older DOS computers), a piece of large industrial equipment that includes a PC-based control interface (such as a CNC milling machine, or SMT parts placement machine), or a deployed system where modifications to internal hardware or software are not permitted for risk management or security reasons (e.g. military systems, ground-based avionics systems), for example. Network 40 is typically a TCP/IP network such as the Internet, but may also be some other network (e.g. an Intranet). Monitoring device 20 is connected to network 40 by a network connection 42. Controlled computing device 30 may also be connected to network 40 by network connection 42 or some other network connection.

[0031] Monitoring device 20 is connected to controlled computing device 30 by several connections, including for example, a video signal connection 50 for carrying video output from monitoring device 20. Monitoring device 20 may also be connected to controlled computing device 30 by other output data signal connections for carrying output from controlled computing device 30, including for example, serial data signal connection 56

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5 connection 54 for carrying mouse input.

10 the controlled computing device 30 are to be monitored and what specific
input devices, if any, are to provide input to the controlled computing device
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15 remotely monitor and control controlled computing device 30 (e.g., as if the user was operating a terminal located in the immediate vicinity of controlled computing device 30). Monitoring device 20 allows remote user 60 to perform maintenance tasks that remote user 60 might otherwise perform locally on controlled computing device 30. For example, remote user 60 may be a
20 system administrator who wishes to maintain the computing controlled device 30 remotely from a network 40, such as the Internet. Although remote user 60 is referred to as "remote", the actual distance between the location of the remote user 60 and controlled computing device 30 will depend on the size and layout of network 40, and the exact location of the remote user 60 on the
25 network. For example, even if the network 40 is an internal network of an organization, remote user 60 may be in the same room as controlled computing device 30 and still be referred to as a "remote" user.

30 device 30 is facilitated by monitoring device 20, which digitizes video output carried by video signal connection 50 (e.g. VGA graphics) from controlled computing device 30, and sends the digitized output to remote user 60 on

network 40 over network connection 42. Input signals from input devices (e.g. keyboard input and/or mouse input) can be simulated by monitoring device 20 as directed by remote user 60 for transmission to controlled computing device 30.

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[0035] Monitoring device 20 may also be configured to transmit signals it receives (e.g. over video signal connection 50 and serial data signal connection 56) to a local output device, such as a display 68 (e.g. a VGA screen) operated by a local user 70, or other device such as a text display device or an output peripheral device. Monitoring device 20 may also be configured to receive signals from local input devices operated by local user 70 such as a local keyboard 72 and a local mouse 74 accessible by local user 70, and to transmit those signals to controlled computing device 30 (e.g. over keyboard signal connection 52 and mouse signal connection 54 respectively).

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[0036] Monitoring device 20 can employ software to multiplex input from the local user 70 and the remote user 60. This means that a user (e.g. local user 70 and/or remote user 60 as configured by the software) can configure the software to "share" or mix the inputs from both local user 70 and remote user 60 for transmission to controlled computing device 30, or the software can enforce a mutual exclusion mechanism, where only one of local user 70 and remote user 60 can be in control of a controlled computing device 30 at any given time. Alternatively, monitoring device 20 may include hardware means (e.g. an input switch) that controls whether input is to be received from remote user 60 or local user 70, and hardware means (e.g. an output switch) that controls the flow of data received by controlled computing device 30 to a remote user 60 or local user 70.

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[0037] Preferably, monitoring device 20 is connected to a relay 80. Relay 80 may be internal to monitoring device 20 or external to monitoring device 20. Monitoring device 20 may be connected to relay 80 by a relay connection 82. Relay 80 controls the power source 84 for controlled

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[0040] Referring now to Figure 2, a schematic diagram that illustrates components of a monitoring device according to an embodiment of the present invention is provided.

5 **[0041]** In this embodiment, monitoring device 20 consists of two stages: a video input stage 90 and a control stage 92. Video input stage 90 and control stage 92 can each be implemented using separate sets of one or more semiconductor devices, circuits, or microprocessors. For example, video
10 input stage 90 may be implemented using a gate array (e.g. an FPGA) while control stage 92 may be implemented using a gate array and a microprocessor chip. Alternatively, the functions of video input stage 90 and control stage 92 could also be distributed across multiple semiconductor devices, circuits, or microprocessors in variant configurations of components of monitoring device 20, or implemented using a single semiconductor device,
15 circuit, or microprocessor. Monitoring device 20 may comprise more or less stages in variant embodiments of the invention.

[0042] Video input stage 90 is designed to receive signals from controlled computing device 30, such as video signals over video signal
20 connection 50. Output data signals over a serial data signal connection 56, for example, are received by control stage 92, although in variant embodiments, a different stage may receive output signals from controlled computing device 30 for subsequent transmission to control stage 92. Signals received from controlled computing device 30 by video input stage 90 can be
25 transmitted to a local user (e.g. 70 of Figure 1) using display 68, and/or communicated to control stage 92 for transmission to a remote user (e.g. 60 of Figure 1) over network connection 42.

[0043] If desired, analog signals received from controlled computing
30 device 30 such as video signals can be digitized using an analog-to-digital converter (ADC) 94 before transmission to a user (e.g. a remote user 60). For instance, three analog signals (e.g. red, green, and blue) can be

simultaneously digitized and converted into digits. In Figure 2, ADC 94 is positioned to receive analog signals from video input stage 90 before communicating digitized signals to control stage 92. However, in variant configurations of monitoring device 20, ADC 94 may be connected to different components and may digitize signals earlier or later in the process of transmitting analog signals received from controlled computing device 30 to a user in digitized form. Furthermore, digitized output of ADC 94 may be stored in a memory 96 for subsequent retrieval by control stage 92.

10 [0044] ADC 94 can be embodied in its own device, or contained within other devices (e.g. as part of video input stage 90 or control stage 92). These devices may also performing timing recovery functions, as is needed to accurately sample high-speed (e.g. 250 MHz bandwidth) video signals. A single ADC 94 may be used to digitize signals from one controlled computing device 30 or multiple controlled computing devices 30 at a time. Alternatively, a dedicated ADC 94 could be assigned to each of multiple controlled computing devices 30. However, it may be more cost-effective to have shared resources such as ADCs 94, for all computing devices. Other configurations of ADCs 94 may also be used.

20 [0045] Control stage 92 controls the simulation or emulation of input data to be transmitted to controlled computing device 30. The simulation or emulation of input data can be performed by an input signal emulator 98, which can be a separate device such as a microprocessor, and which communicates with control stage 92. The input data that is simulated or emulated can be generated automatically by control stage 92, or at the direction of remote user 60 or local user 70 as described in further detail below. While the functions of input signal emulator 98 may be integrated into another device in variant configurations of monitoring device 20, the use of a separate device may, advantageously, permit the simulation or emulation functions to continue even if power to monitoring device 20 is removed. This can be facilitated by powering the input signal emulator 98 from the power

source of the controlled computing device 30 (e.g. via the same pins which exist in local keyboard 72 and local mouse 74).

[0046] Control stage 92 may also be designed to receive signals from

5 local input devices such as a local keyboard 72 or local mouse 74, for example. Signals from local input devices can be received by an input signal receiver 100 that communicates with control stage 92. The signals can then be transmitted to controlled computing device 30 using input signal emulator 98, over keyboard signal connection 52 and mouse signal connection 54, for example. However, in some uses of the present invention, where only remote access to controlled computing device 30 is required for example, video input stage 90 need not be configured to receive signals from local input devices. In the configuration of Figure 2, input signal receiver 100 exists as a separate device; however, the functions of input signal receiver 100 may be integrated with other devices (e.g. those which implement control stage 92) in variant configurations of monitoring device 20.

[0047] Control stage 92 is designed not only to transmit signals

received from controlled computing device 30 to remote user 60, but also to
20 transmit signals relating to input data (e.g. keyboard input and mouse input)
from remote user 60 to controlled computing device 30. The input data that is
to be transmitted to controlled computing device 30 may be received by
remote user 60 over network connection 42. In this case, input data received
from remote user 60 can be transmitted to controlled computing device 30,
25 through input signal emulator 98, allowing remote user 60 to remotely monitor
and control controlled computing device 30.

[0048] Control stage 92 can also control the movement of a relay (e.g.

80 of Figure 1) using relay connection 82, in order to power on and power off
30 controlled computing device 30. For example, if software running on
controlled computing device 30 has crashed or controlled computing device
30 is otherwise not working properly, and it is desired that controlled

computing device 30 be turned off and restarted (i.e. rebooted), controlled computing device 30 can first power off the controlled computing device 30 if controlled computing device 30 is not already powered off, possibly for a pre-determined amount of time (e.g. several seconds for a simple reboot, several minutes if the controlled computing device 30 is to be cooled, or some other duration depending on the reason for rebooting), and subsequently power on controlled computing device 30. Relay 80 may be controlled in response to a request from remote user 60, or by control stage 92 without direction from remote user 60.

[0049] Referring to Figure 3A, a schematic diagram that illustrates components of a monitoring device in a variant embodiment of the present invention is provided. In this embodiment, monitoring device 20 comprises one or more multiplexers 102 (in the form of one or more semiconductor devices or one or more circuits, for example) to allow multiple controlled computing devices 30 to be controlled and monitored. Multiplexers 102 can be controlled by control stage 92, which can select a specific controlled computing device 30 to be monitored and/or controlled by remote user 60 or local user 70. Preferably, when multiple controlled computing devices 30 are connected to monitoring device 20, separate input signal emulators 98 are used to transmit signals from input devices such as a keyboard and mouse to each of the controlled computing devices 30. This allows emulated input to be generated for each controlled computing device 30 at all times, even if it is not the selected specific controlled computing device 30 being directly monitored and/or controlled by remote user 60 and local user 70. For example, even though remote user 60 and local user 70 may be viewing the video output of the selected specific controlled computing device 30 and controlling the selected specific controlled computing device 30 (either by remote user 60, local user 70, or both depending on how monitoring device 20 is configured), emulated input may still be provided to all other controlled computing devices 30 to allow automatic monitoring (e.g. in the "background") by control stage 92.

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[0050] Referring to Figure 3B, a schematic diagram that illustrates components of a monitoring device in another variant embodiment of the present invention is provided. In this embodiment, monitoring device 5 comprises two sets of one or more multiplexers 102 (each set in the form of one or more semiconductor devices or one or more circuits, for example). A first set of multiplexers 102 can be used to allow a first specific controlled computing device 30 to be selected for monitoring and controlling by a first user (e.g. remote user 60 of Figure 1), while a second set of multiplexers 102 can be used to allow a second specific controlled computing device 30 to be selected for monitoring and controlling by a second user (e.g. local user 70 of Figure 1). The first specific controlled computing device 30 to be selected for monitoring and controlling by the first user may or may not be different from the second specific controlled computing device 30 selected for monitoring and controlling by the second user. Again, preferably, separate input signal emulators 98 are used to transmit signals from input devices such as a keyboard and mouse to each of the controlled computing devices 30. Emulated input may be generated for each controlled computing device 30 at all times, even if a given controlled computing device 30 is not being directly controlled or monitored by either the first or second users.

[0051] In other variant embodiments of the invention, multiple local and/or remote users may monitor and control a controlled computing device 30. For example, a group of ten local and/or remote users may all be viewing 25 the same output from a selected controlled computing device 30, and each user of the group may provide input to the selected controlled computing device 30. Multiple sets of multiplexers 102 may be used to allow multiple local and/or remote users to monitor and control the selected controlled computing device 30. Multiple sets of multiplexers 102 may also be used to 30 allow each of multiple local and/or remote users to monitor and control different controlled computing devices 30 of a group of multiple computing devices. In some variant embodiments, multiple video input stages 90 and

control stages 92 may be implemented to permit access to multiple computing devices by multiple users.

[0052] Referring back to Figure 2, which illustrates components of monitoring device 20 in an embodiment of the present invention, monitoring device 20 may also be configured to facilitate the monitoring of controlled computing device 30 for error conditions. Error conditions are conditions which, if present in the controlled computing device 30, usually indicate that controlled computing device 30 is not functioning properly, or that controlled computing device 30 is functioning in some other specified (usually undesired) manner. These error conditions are detected by monitoring device 20 by monitoring the electrical outputs of the controlled computing device 30, typically at some regular interval.

[0053] A monitoring device 20 configured to facilitate the monitoring of controlled computing device 30 for error conditions may also be configured to permit remote control of controlled computing device 30 by a remote user as described earlier in this specification with reference to Figure 2. However, it will be apparent to those skilled in the art that a monitoring device 20 configured to facilitate the monitoring of controlled computing device 30 for error conditions in accordance with the present invention may exist as a separate device, and need not provide for remote control capabilities (other than what may be necessary to monitor error conditions).

[0054] A monitoring device 20 configured to facilitate the monitoring of controlled computing device 30 for error conditions may exist in a system that contains fewer components than system 10 of Figure 1, since some of the components of system 10 (e.g. local display 68, local mouse 74) may not be required to monitor error conditions in the controlled computing device 30.

[0055] The monitoring of controlled computing device 30 for error conditions can be performed automatically by monitoring device 20 without

the need for intervention by a user or the need for ongoing direct maintenance of controlled computing device 30 or monitoring device 20 by a user.

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[0056] In a preferred embodiment of the invention, video input stage 90 is adapted to receive one or more video signals to be transmitted to control stage 92 (via other devices such as ADC 94 and a memory 96). Other signals such as an output data signal over serial data signal connection 56 may also be transmitted to and received by control stage 92. These signals received from controlled computing device 30 can be used by control stage 92 to monitor controlled computing device 30.

[0057] Signals received from controlled computing device 30 may have been generated by controlled computing device 30 in response to test signals transmitted to controlled computing device 30 by control stage 92 prior to the reception of the signals by components of monitoring device 20.

[0058] Signals received from controlled computing device 30 by control stage 92 are used to determine whether an error condition is present in controlled computing device 30. Typically, only a subset of all signals received from controlled computing device 30 are necessary to determine whether any particular error condition is present in controlled computing device 30. If it is determined that an error condition is present in controlled computing device 30, control stage 92 generates an error indicator (e.g. a signal that identifies a specific detected error condition) to indicate that the error condition is present in controlled computing device 30. The error indicator may then be output to a remote user 60 or to a local user 70 (e.g. using a set of LEDs). Alternatively, the error indicator (or some form thereof) may be stored in a memory or storage device.

[0059] Control stage 92 comprises software [not separately shown] can be configured to permit the monitoring device 20 to determine (i.e. detect) what specific conditions that may be present in a controlled computing device

30 are to be treated as error conditions. A default set of error conditions to be monitored can be defined. Alternatively, a user (remote user 60 or local user 70) may be given the facility to select specific error conditions to be monitored by the monitoring device 20.

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[0060] The software can also generate a message from a generated error indicator. The message may comprise data for a log record that can be stored in a storage device such as a memory 102 internal to monitoring device 20 or some other storage device internal or external to monitoring device 20, for later retrieval (e.g. by a remote user 60 of Figure 1). The data may include, for example, a record of the time and date the error condition was determined (i.e. detected), data items from data received from controlled computing device 30, and/or other information as desired.

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[0061] The message may also be one that is sent to a remote user 60 on a network (e.g. 40 of Figure 1) through network connection 42. In this case, the message may be an electronic mail message, or a message for transmission to a pager, cell phone, other portable communications device, or any other device connected to the network. Since many of these devices can receive messages, a user may be alerted to a potential problem with controlled computing device 30 almost instantaneously. The message may also be generated by module 100 in a variety of formats as is known.

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[0062] Optionally, when control stage 92 determines that an error condition is present in controlled computing device 30, control stage 92 may cause relay 80 that controls power to controlled computing device 30 to move to the "off" position (possibly for a pre-determined period of time) to power off the controlled computing device 30, and subsequently to move relay 80 to the "on" position in order to power on the controlled computing device 30, in order to effect a reboot of controlled computing device 30. This assumes that the controlled computing device 30 is able to start running on its own after the reboot.

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[0063] Some examples of error conditions that may become present in a controlled computing device 30 during its operation, and which may be monitored and detected by monitoring device 20 are described below.

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[0064] Text mode detection: Many computing devices output high resolution graphics signals when they are operating normally (e.g. when Microsoft Windows is active). However, during the reboot phase of a computing device's operation, the computing device operates in a special video mode called "text mode". This text mode has special electrical properties which can be detected from the output of controlled computing device 30. For example, "text mode" can be defined as any video mode with 720 pixels of resolution horizontally, and/or a horizontal signal of less than 40 KHz. However, other definitions of "text mode" as known in the art may be employed. Thus, monitoring device 20 can be configured to detect the "text mode" as an error condition, a condition that usually indicates that the computing device has reset itself (of its own accord) or has crashed with an error message on the screen (sometimes called the "blue screen of death").

[0065] String detection: An output data port such as a serial port (e.g. RS-232) of controlled computing device 30 can be monitored for a prespecified string of characters. Monitoring device 20 can be configured to either expect the prespecified string within a prespecified period (e.g. once every 5 minutes), or alternatively, to not expect the prespecified string. If either case fails to occur, as configured, the monitoring device 20 considers it as an error condition. The monitoring of this error condition can be useful if serial error messages are output over a serial port. A message generated from an error indicator may include these serial error messages as part of the message. Other output data signals from controlled computing device 30 can be monitored for the presence (or lack thereof) of a prespecified string of characters.

[0066] Keyboard light detection: Monitoring device 20 can be configured to continuously simulate the pressing of a "Num Lock" keyboard key (or some other key such as "Caps Lock" or "Scroll Lock", for example) as input to a controlled computing device 30. If controlled computing device 30 is operating properly, it will transmit a signal to illuminate the corresponding "Num Lock" light (or other light if a different key was used) on local keyboard 72 in response. Monitoring device 20 is configured to detect if this fails to occur, and considers the failure an error condition. Typically, this failure indicates a serious software failure or lock-up on controlled computing device 30.

[0067] Echo detection: Many computers can be connected to a network (e.g. 40 of Figure 1) such as an internal local area network (LAN) or the Internet. They often perform some function over that network. A failure of controlled computing device 30 to respond to network inquiries typically indicates a failure. Monitoring device 20 can be configured to generate "ping" requests for transmission to controlled computing device 30. The ping requests should elicit an "echo" response whenever they are received by controlled computing device 30. Monitoring device 20 can be configured to monitor controlled computing device 30 for responses to generated ping requests. If more than a prespecified percentage (e.g. 50%) of such ping requests do not elicit an echo response within a prespecified period of time, then an error condition is detected. This error may be the result of a network failure or a software crash on the controlled computing device 30, for example.

[0068] Monitoring device 20 can also be configured to generate requests to retrieve a web page from controlled computing device 30, if controlled computing device 30 is a web server. Monitoring device 20 simulates a request to retrieve a web page, and if the web page fails to be retrieved successfully from controlled computing device 30 in response to the request, an error condition is detected. A successful retrieval of a web page

may be deemed any retrieval of a non-zero number of bytes within a reasonable, possibly prespecified, time-limit. However, other criteria may be used to determine what constitutes a successful retrieval of a web page.

5 **[0069]** Monitoring device 20 may also be configured to detect other error conditions, including non-responsiveness to simulated mouse movements by monitoring video signals from a controlled computing device 30, and loss of power to controlled computing device 30, for example.

10 **[0070]** Monitoring device 20 may be configured to monitor controlled computing device 30 for one, some, or all of the above error conditions, and/or other error conditions if desired.

15 **[0071]** Figure 4 is a flowchart illustrating the steps of a method of monitoring a computing device in accordance with an embodiment of the present invention. The method is shown generally as 110 and commences at step 112.

20 **[0072]** At step 114, optionally, generated test signals may be transmitted by a monitoring device (e.g. 20 of Figure 2) to a controlled computing device (e.g. 30 of Figure 2) if test signals are required to detect whether a specific error condition is present in the controlled computing device.

25 **[0073]** At step 116, signals generated by the controlled computing device are received by the monitoring device for consideration.

30 **[0074]** At step 118, the monitoring device determines whether an error condition is present in the controlled computing device from the signals received at step 116. The monitoring device determines if, for example:

- (i) the controlled computing device is operating in a "text mode";

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- (ii) data output from the controlled computing device fails to comprise a prespecified string of characters within a prespecified period of time or data output from the controlled computing device comprises a prespecified string of characters where none is expected;
- (iii) a signal to illuminate a prespecified light on a keyboard in response to the simulation of the pressing of a prespecified keyboard key is not received from the controlled computing device;
- (iv) echo requests are not received in response to a prespecified percentage of ping requests within a prespecified period of time; and/or
- (v) a web page is not successfully retrieved in response to a request to retrieve a web page from the controlled computing device.

The nature of these error conditions were described in greater detail with reference to Figure 2. Other error conditions may be monitored by the monitoring device. Multiple error conditions, possibly as selected by a user, may be monitored by the monitoring device.

[0075] At step 120, if the monitoring device has determined that an error condition is present in the controlled computing device at step 118, an error indicator associated with that error condition is generated. This error indicator may be used to output an indication of the error condition to a local user (e.g. using a set of LEDs), a remote user, or to a storage device or a memory.

[0076] At step 122, optionally, a message may be generated and output if an error indicator is generated at step 120. The message may be data for a log record to be stored in a storage device (e.g. a memory), or a message to be delivered to a user on a network in the form of an electronic

5 condition was determined to be present in the controlled computing device,
data items from data received from controlled computing device at step 116,
or other information.

10 the controlled computing device is connected to both the controlled computing device and a power source for the controlled computing device, if it is determined at step 118 that an error condition is present in the controlled computing device, the controlled computing device can be rebooted by moving the relay to the "off" position (possibly for some pre-determined period of time) if it is currently in the "on" position, and then moving the relay back to the "on" position. This causes the controlled computing device to be powered off and then on, effecting a reboot of the controlled computing device.

[0078] At step 126, it is determined whether steps in method 110 are to be repeated to continue the monitoring of the controlled computing device. If so, the flow of method steps proceeds back to step 114. Otherwise, the flow of method steps proceeds to step 128. Step 128 marks the end of method 110.

25 **[0079]** Most preferably, the controlled computing device is monitored for error conditions regularly at some predefined interval. The steps of method 110 may be repeated at the predefined interval. The steps of method 110 may also be repeated for different error conditions, and several instances of the method 110 may be performed simultaneously to monitor the controlled
30 computing device for the different error conditions. The steps of each instance of the method 110 being performed may be repeated at different predefined intervals.

[0080] The present invention has been described with regard to preferred embodiments. However, it will be obvious to persons skilled in the art that a number of variants and modifications can be made without departing
5 from the scope of the invention as described herein.

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